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(54) **ELECTRONIC DEVICE AND METHOD FOR WIRELESS COMMUNICATION**

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H03F 3/24 (2006.01)

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(58) **Field of Classification Search**
CPC H04B 1/44; H03F 3/24; H03F 2200/451
See application file for complete search history.

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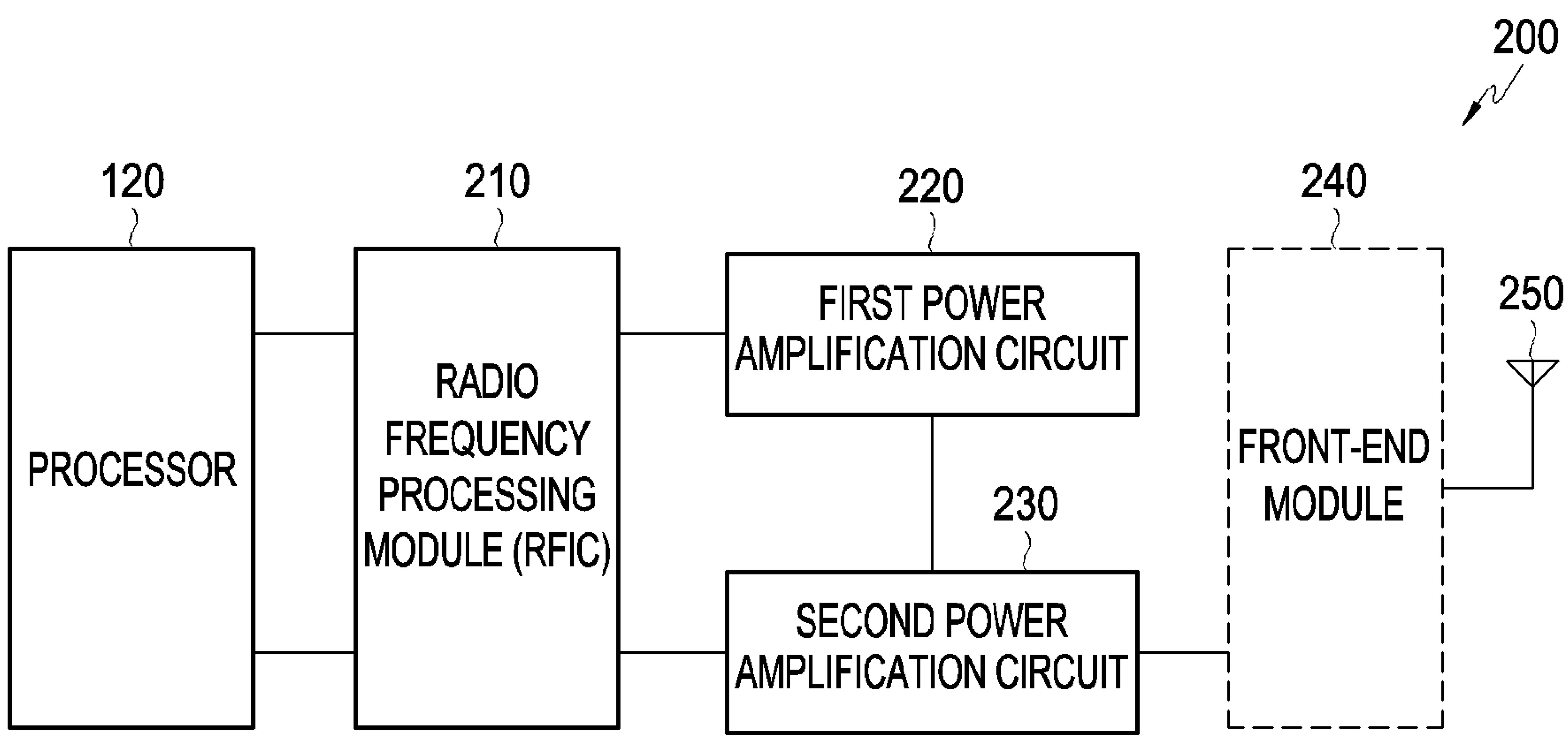
(74) *Attorney, Agent, or Firm* — Nixon & Vanderhye, P.C.

(57) **ABSTRACT**

The disclosure relates to an electronic device and a method for wireless communication including a power amplification circuit. According to an embodiment, an electronic device may include: a radio frequency processing module comprising radio frequency circuitry, a first power amplification circuit connected to the radio frequency processing module, a second power amplification circuit connected to the radio frequency processing module and the first power amplification circuit, and a front-end module comprising circuitry connected to the second power amplification circuit and an antenna and configured to transmit a signal, wherein the second power amplification circuit is configured to acquire, from the first power amplification circuit, a first signal obtained by amplifying a signal output from the radio frequency processing module and a second signal by amplifying a signal output from the radio frequency processing module.

15 Claims, 7 Drawing Sheets



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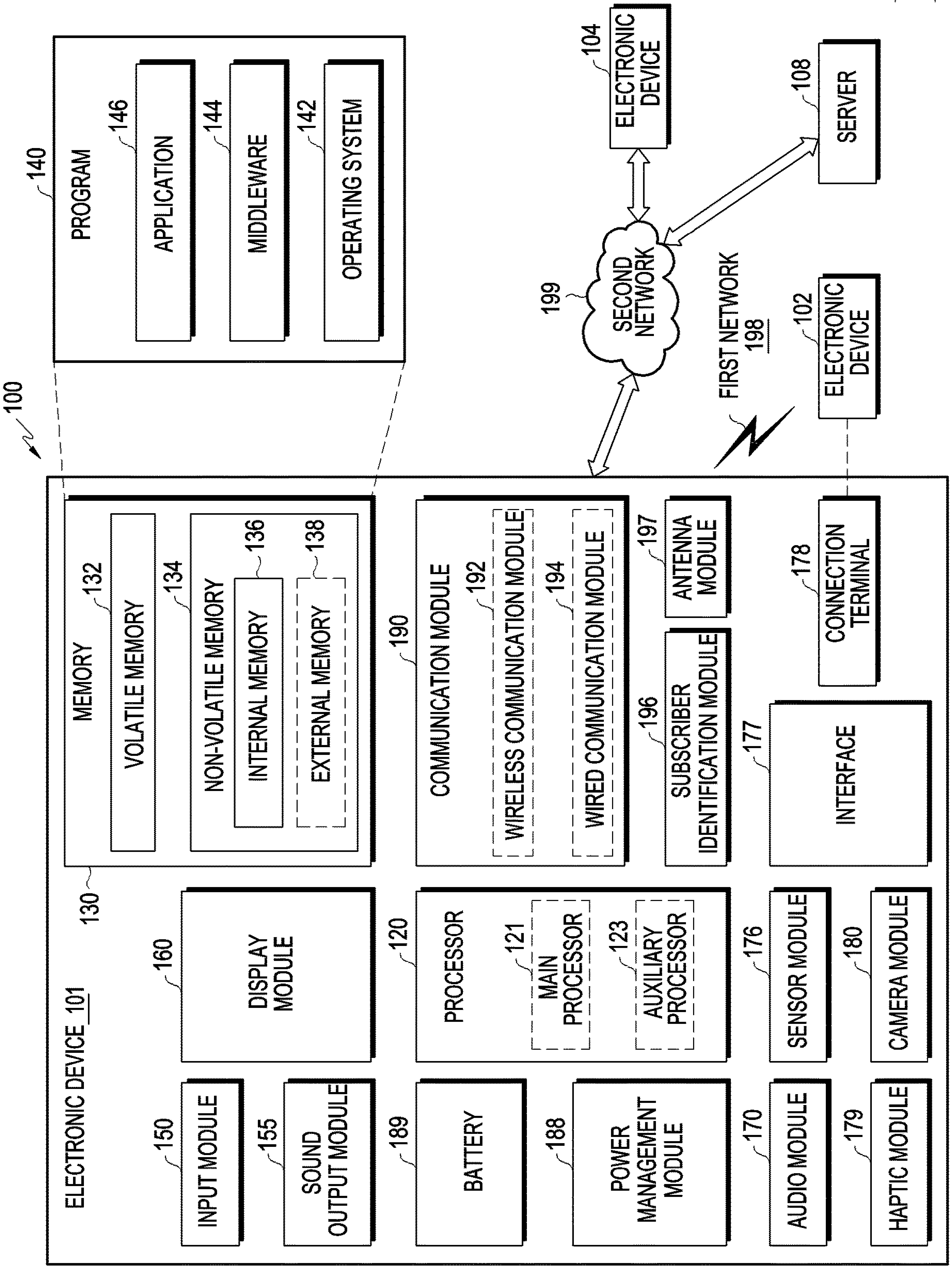
100
ELECTRONIC DEVICE 101
INPUT MODULE
150
SOUND OUTPUT MODULE
155
BATTERY
189
POWER MANAGEMENT MODULE
188
AUDIO MODULE
170
HAPTIC MODULE
179
DISPLAY MODULE
160
PROCESSOR
120
MAIN PROCESSOR
121
AUXILIARY PROCESSOR
123
SENSOR MODULE
176
CAMERA MODULE
180
MEMORY
130
VOLATILE MEMORY
132
NON-VOLATILE MEMORY
134
INTERNAL MEMORY
136
EXTERNAL MEMORY
138
COMMUNICATION MODULE
190
WIRELESS COMMUNICATION MODULE
192
WIRED COMMUNICATION MODULE
194
SUBSCRIBER IDENTIFICATION MODULE
196
ANTENNA MODULE
197
INTERFACE
177
CONNECTION TERMINAL
178
PROGRAM
140
APPLICATION
146
MIDDLEWARE
144
OPERATING SYSTEM
142
SECOND NETWORK
199
FIRST NETWORK 198
ELECTRONIC DEVICE
102
ELECTRONIC DEVICE
104
SERVER
108

FIG.1

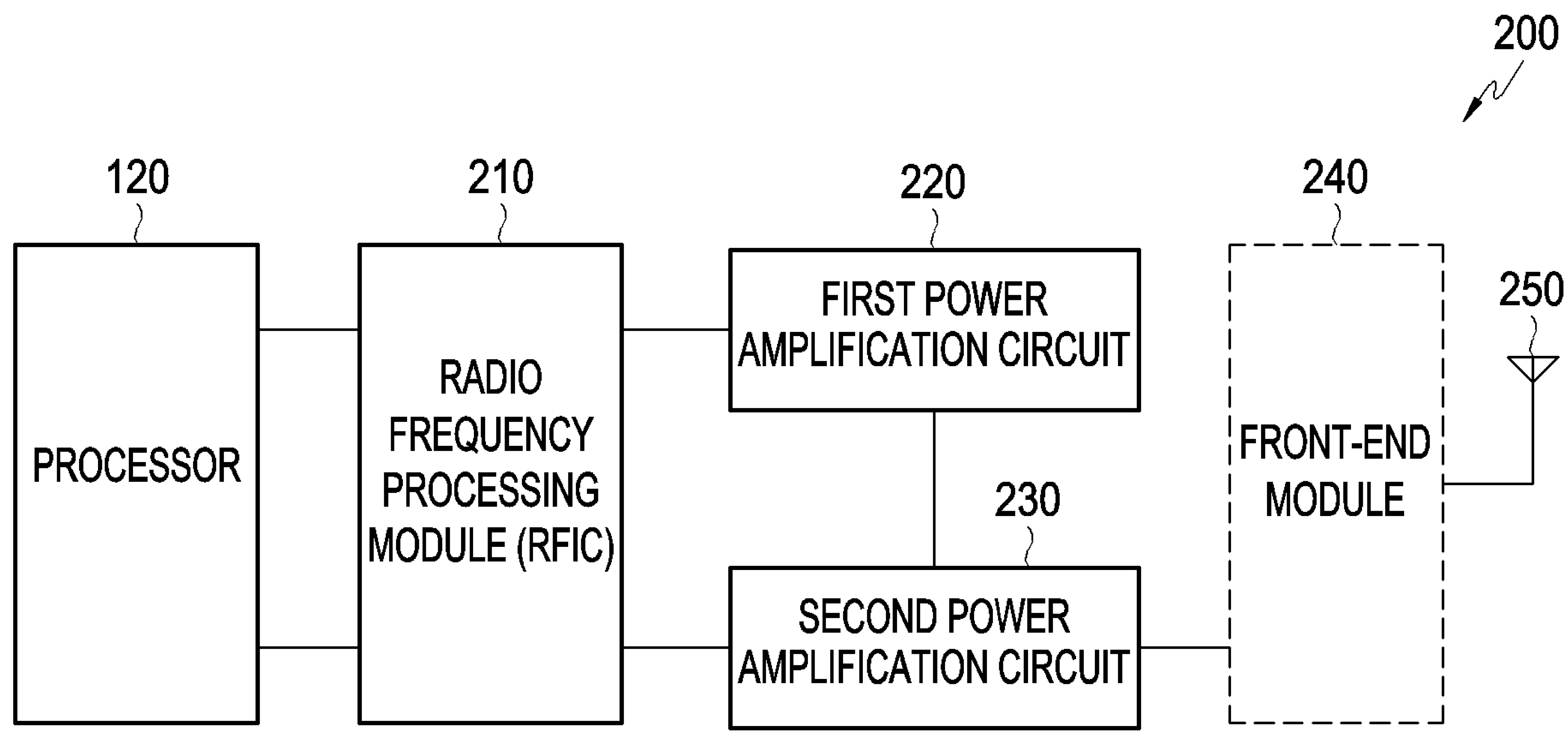
200
120
210
220
240
250
PROCESSOR
RADIO FREQUENCY PROCESSING MODULE (RFIC)
FIRST POWER AMPLIFICATION CIRCUIT
230
SECOND POWER AMPLIFICATION CIRCUIT
FRONT-END MODULE

FIG.2

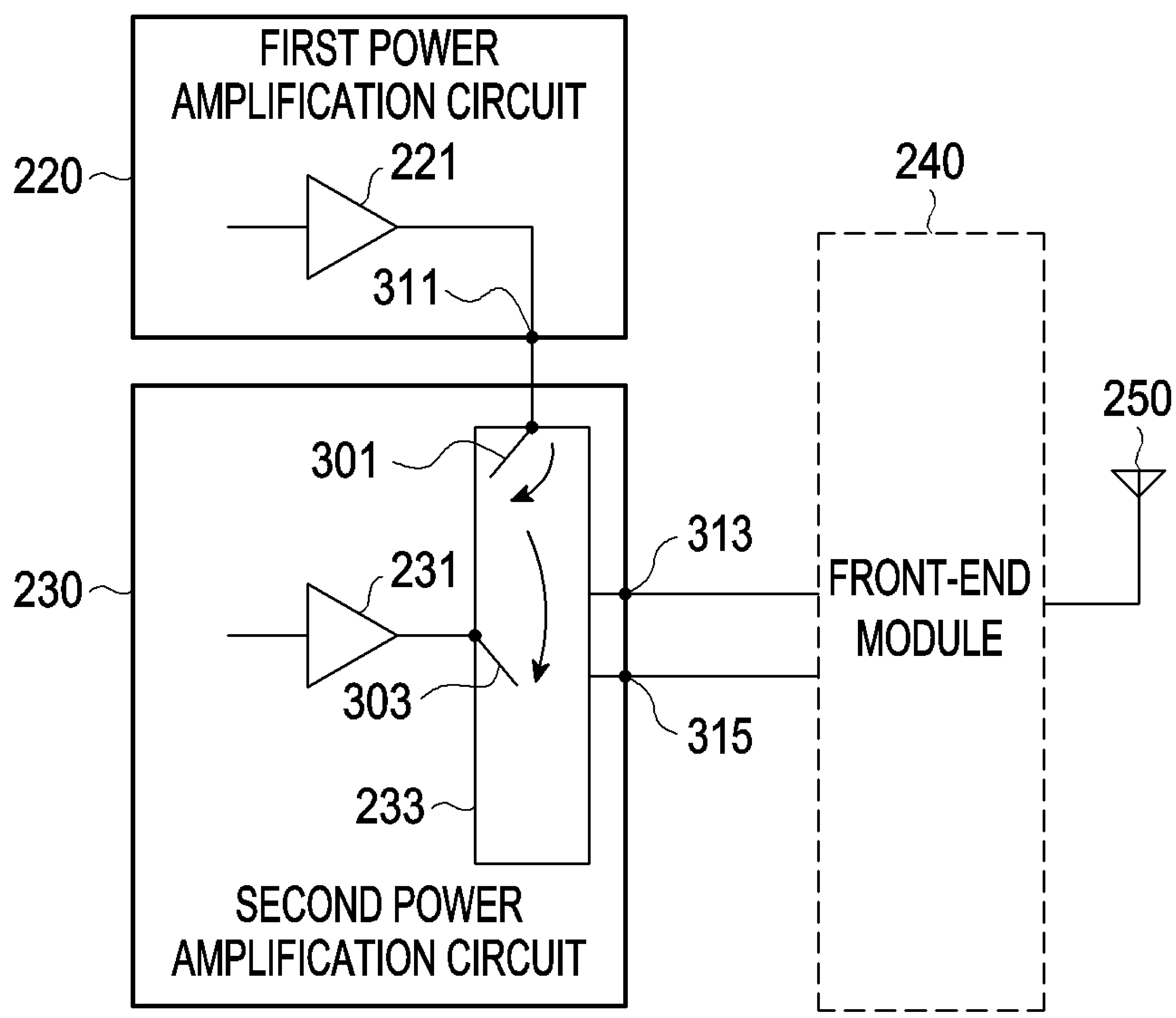
FIRST POWER AMPLIFICATION CIRCUIT
220
221
311
240
250
301
313
230
231
303
315
233
FRONT-END MODULE
SECOND POWER AMPLIFICATION CIRCUIT

FIG.3

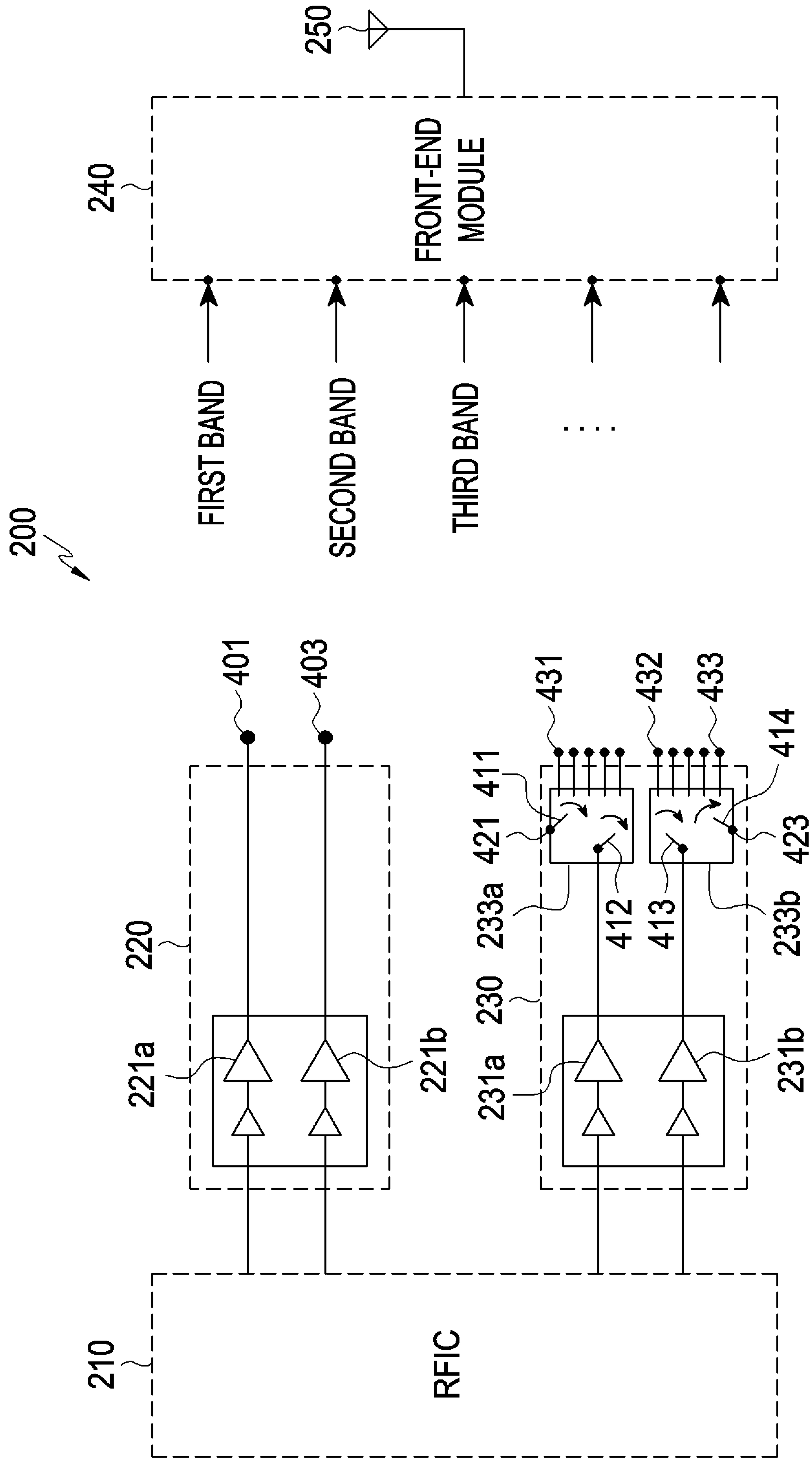
250
240
FRONT-END MODULE
FIRST BAND
SECOND BAND
THIRD BAND
....
200
401
403
220
221a
221b
431
432
433
411
421
414
423
233a
412
413
233b
230
231a
231b
210
RFIC

FIG.4A

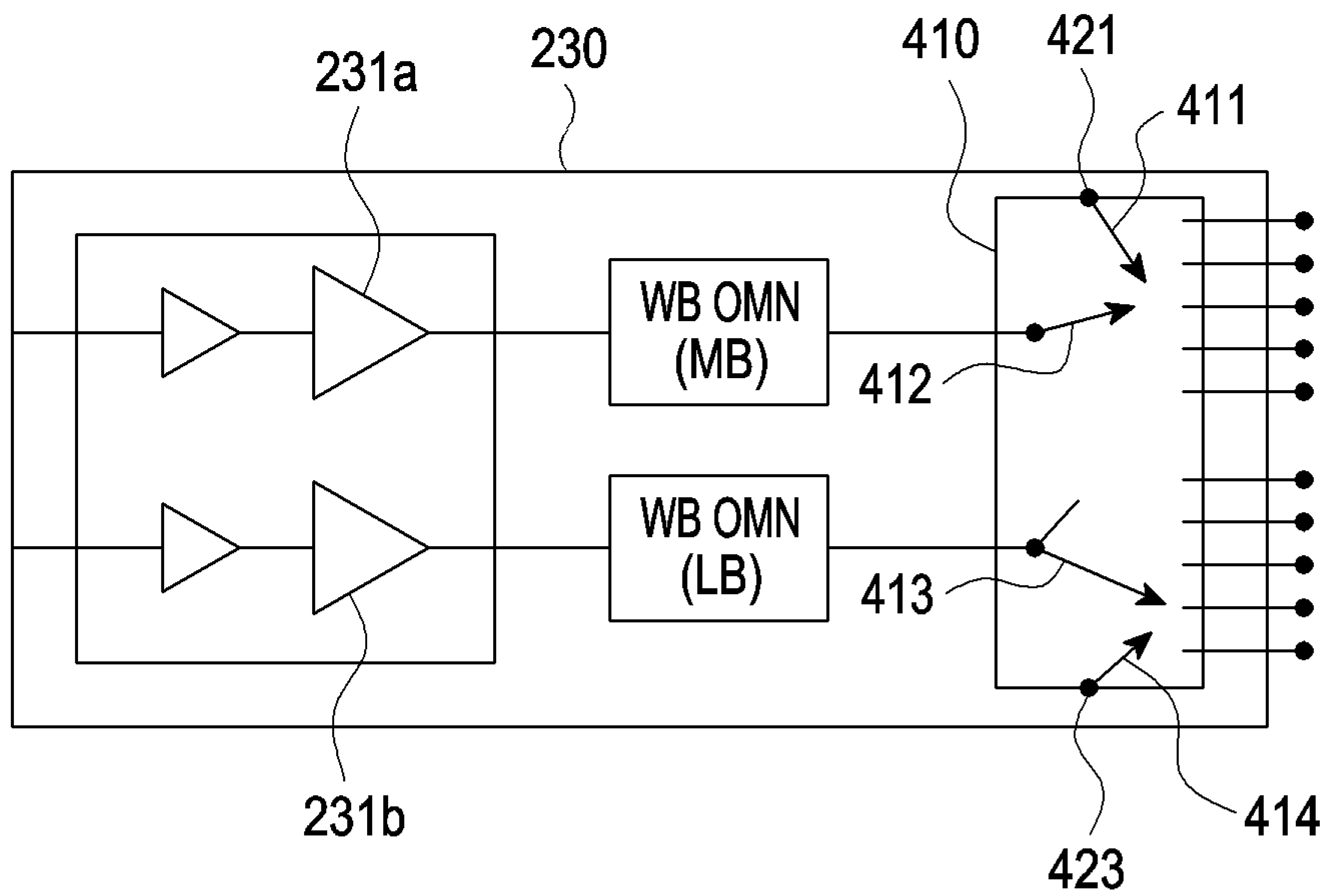

FIG.4B

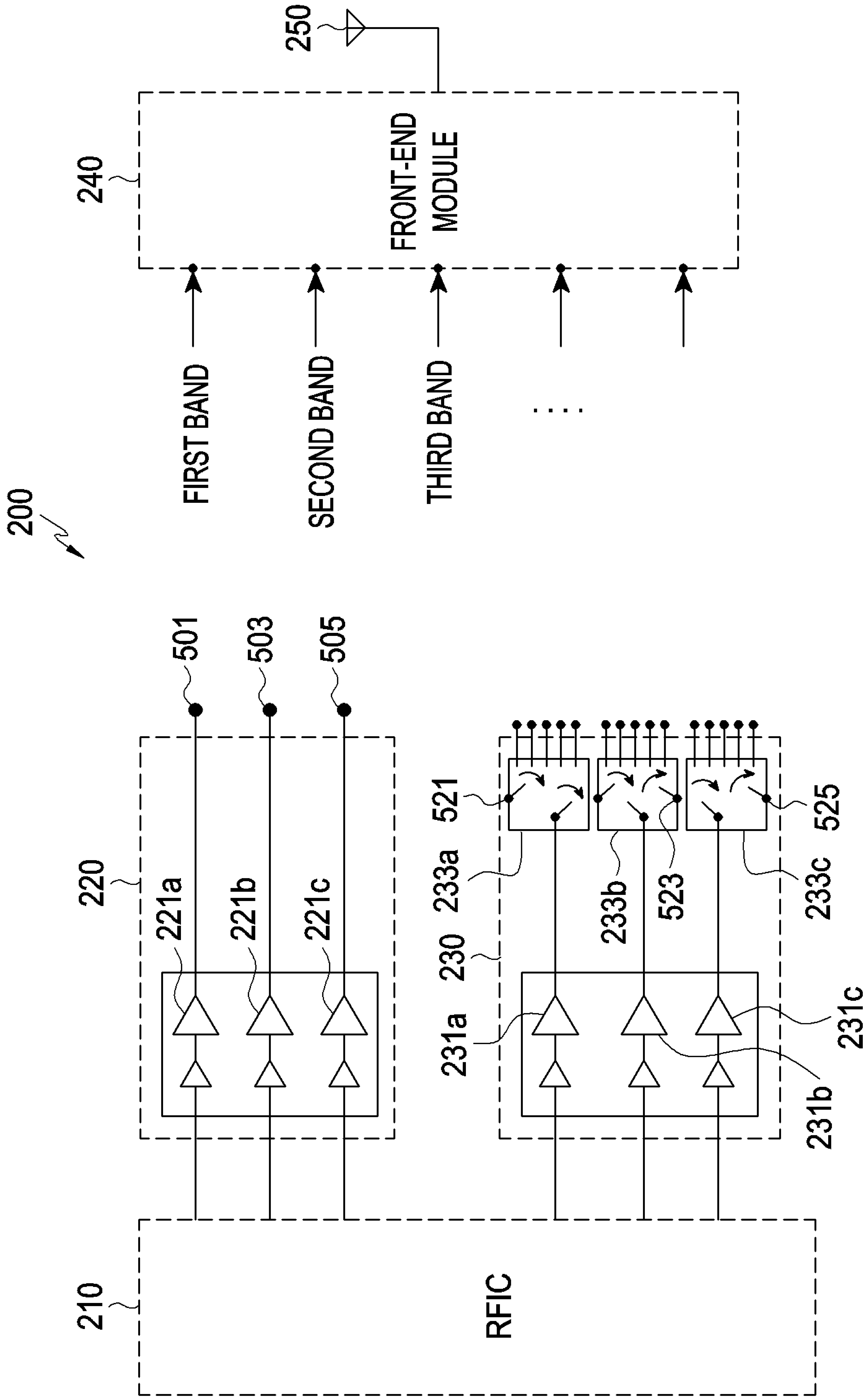
250
240
FRONT-END MODULE
FIRST BAND
SECOND BAND
THIRD BAND
....
200
220
221a
221b
221c
501
503
505
521
233a
233b
523
233c
525
230
231a
231b
231c
210
RFIC

FIG.5

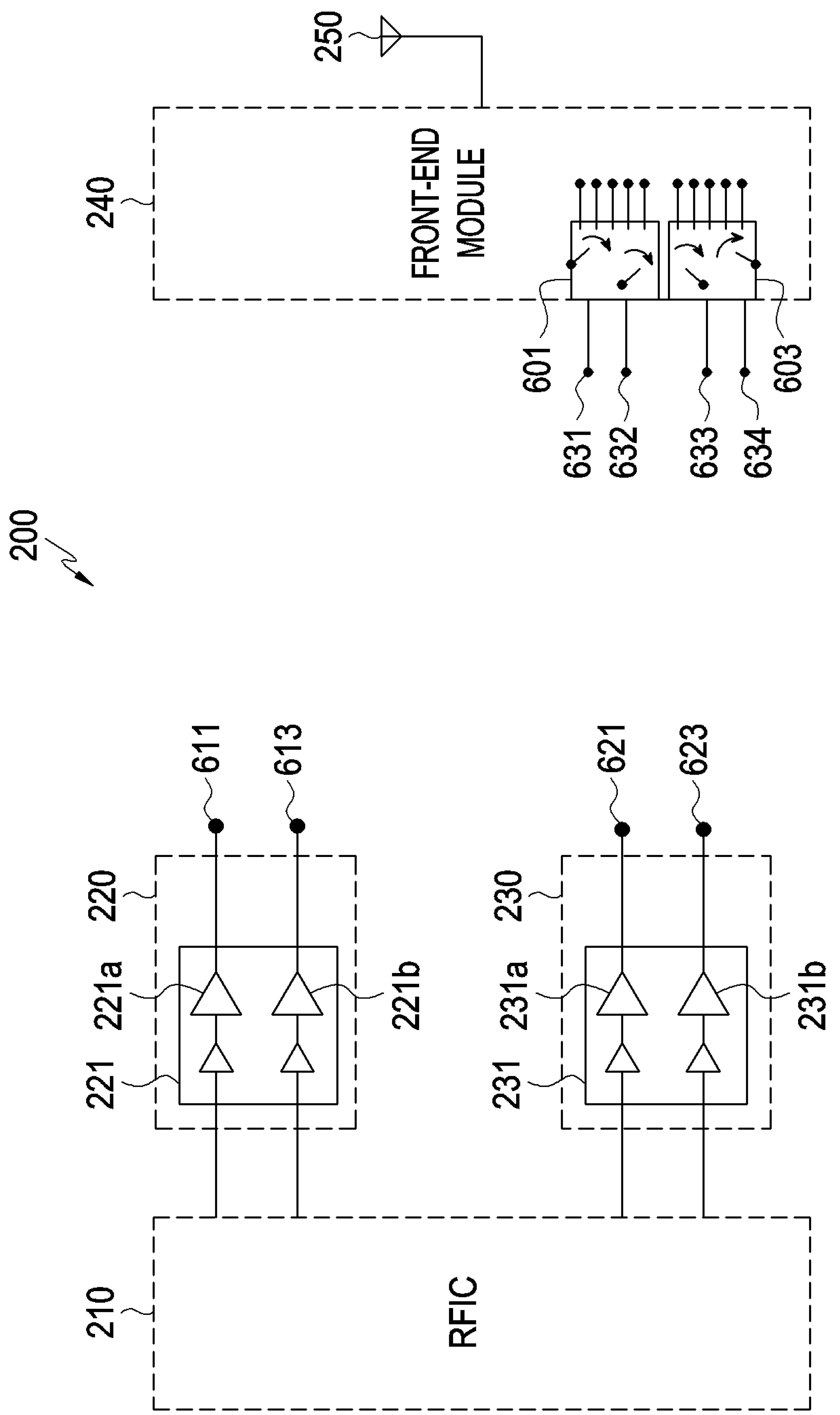
250
240
FRONT-END MODULE
601
603
631
632
633
634
200
611
613
621
623
220
221a
221b
221
230
231a
231b
231
210
RFIC

FIG.6

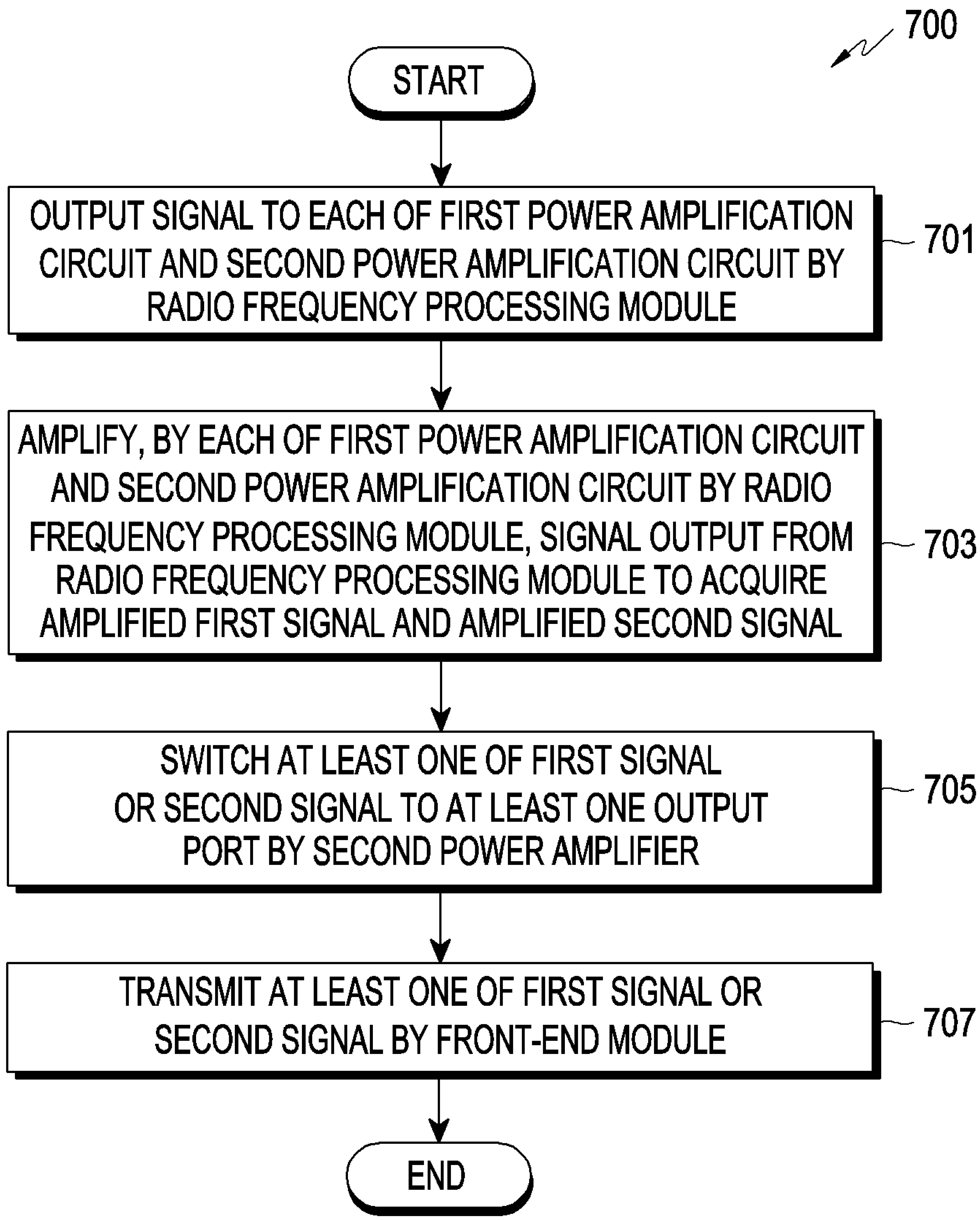
700
START
OUTPUT SIGNAL TO EACH OF FIRST POWER AMPLIFICATION CIRCUIT AND SECOND POWER AMPLIFICATION CIRCUIT BY RADIO FREQUENCY PROCESSING MODULE
701
AMPLIFY, BY EACH OF FIRST POWER AMPLIFICATION CIRCUIT AND SECOND POWER AMPLIFICATION CIRCUIT BY RADIO FREQUENCY PROCESSING MODULE, SIGNAL OUTPUT FROM RADIO FREQUENCY PROCESSING MODULE TO ACQUIRE AMPLIFIED FIRST SIGNAL AND AMPLIFIED SECOND SIGNAL
703
SWITCH AT LEAST ONE OF FIRST SIGNAL OR SECOND SIGNAL TO AT LEAST ONE OUTPUT PORT BY SECOND POWER AMPLIFIER
705
TRANSMIT AT LEAST ONE OF FIRST SIGNAL OR SECOND SIGNAL BY FRONT-END MODULE
707
END

FIG.7

ELECTRONIC DEVICE AND METHOD FOR WIRELESS COMMUNICATION

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of International Application No. PCT/KR2021/019729 designating the United States, filed on Dec. 23, 2021, in the Korean Intellectual Property Receiving Office and claiming priority to Korean Patent Application No. 10-2020-0183745, filed on Dec. 24, 2020, in the Korean Intellectual Property Office, the disclosures of which are incorporated by reference herein in their entireties.

BACKGROUND

Field

The disclosure relates to an electronic device and a method for wireless communication in a wireless communication system supporting different communication schemes.

Description of Related Art

With development of communication technology, a next-generation communication scheme such as a 5G communication scheme has been introduced to wireless communication, and a scheme (E-UTRAN new radio dual connectivity (ENDC)) which increases a data transmission rate by utilizing both schemes of a 4G (long-term evolution (LTE)) communication scheme and a 5G (new radio (NR)) communication scheme is being developed.

When a 4G (LTE) communication scheme and a 5G (NR) communication scheme use the same frequency band, the 5G (NR) communication scheme may have a maximum of 100 MHz of a bandwidth (BW) wider than 20 MHz in the 4G (LTE), and cyclic-prefix orthogonal frequency division multiplexing (CP-OFDM) is also used for TX communication, and thus, PARP increases compared to DFS-s-OFDM which has been used in the 4G (LTE). When the 5G (NR) communication scheme is to be supported to secure linearity, a power amplification circuit used in the 4G (LTE) communication scheme cannot be used, and a separate power amplification circuit supportable in the 5G (NR) communication scheme can be used.

When a separate power amplification circuit (PA) in a scheme (LTE+NR ENDC) supporting both communication schemes of the 4G (LTE) communication scheme and the 5G (NR) communication scheme is implemented, a case in which each power amplification circuit is to support the same frequency band may occur as the number of combinations of frequency bands in the ENDC scheme increases. In this case, to connect an output terminal of each power amplification circuit and a front-end module (FEM) of a wireless communication module, a switch (single-pole double-throw (SPDT) switch) is to be used in the back end of output of the power amplification circuit. Various services are provided through the 5G (NR) communication scheme and combinations of frequency bands in the ENDC scheme required by a business operator vary, and thus, use of the SPDT switch may increase for each frequency band according to the supported combination of frequency bands. Accordingly, when two PAs are used in an electronic device for wireless communication supporting the 4G (LTE) communication scheme and the 5G (NR) communication scheme, costs for implementing the used SPDT switch may increase and the size of a wireless communication circuit may increase.

SUMMARY

Embodiments of the disclosure provide an electronic device using a power amplification circuit configured for efficient wireless communication in a wireless communication system supporting different communication schemes, and a method for wireless communication in the same electronic device.

According to an embodiment of the disclosure, an electronic device may include: a radio frequency processing module comprising a radio frequency circuit, a first power amplification circuit connected to the radio frequency processing module, a second power amplification circuit connected to the radio frequency processing module and the first power amplification circuit, and a front-end module comprising circuit connected to the second power amplification circuit and an antenna and configured to transmit a signal, wherein the second power amplification circuit is configured to: acquire, from the first power amplification circuit, a first signal obtained by amplifying a signal output from the radio frequency processing module and a second signal obtained by amplifying a signal output from the radio frequency processing module based on a combination of frequency bands for a first communication scheme and a second communication scheme, and switch at least one of the first signal or the second signal to at least one output port connected to the front-end module based on a first frequency band of the first signal and a second frequency band of the second signal.

According to an embodiment, a method for wireless communication in an electronic device including a wireless communication module may include: amplifying a signal output from a radio frequency processing module of the wireless communication module by a first power amplification circuit of the wireless communication module based on a combination of frequency bands for a first communication scheme and a second communication scheme, acquiring, as a first signal, an amplification signal output from the first power amplification circuit, and a second signal obtained by amplifying a signal output from the radio frequency processing module based on the combination of the frequency bands, by a second power amplification circuit of the wireless communication module, and switching at least one of the first signal or the second signal to at least one output port connected to a front-end module of the wireless communication module, by the second power amplification circuit, based on a first frequency band of the first signal and a second frequency band of the second signal.

According to an embodiment, when separate power amplification circuits (PAs) in a scheme (LTE+NR ENDC) supporting both communication schemes of a 4G (LTE) communication scheme and a 5G (NR) communication scheme are implemented in an electronic device according to an electronic device and a method for wireless communication, an SPDP switch which has been configured at the back end connected to power amplification circuits may not be used, and thus, a cost of implementing a wireless communication module can be saved, and the size of the wireless communication module can be reduced so that a space mounted in the electronic device can be reduced, whereby more efficient wireless communication can be performed.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages of certain embodiments of the present disclosure will be more apparent from the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram illustrating an example electronic device in a network environment according to various embodiments;

FIG. **2** is a block diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment;

FIG. **3** is a block diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment;

FIGS. **4**A and **4**B is a diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment;

FIG. **5** is a diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment;

FIG. **6** is a diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment; and

FIG. **7** is a flowchart illustrating an example method of operating an electronic device according to an embodiment.

With reference to description of drawings, the same or similar reference signs may be used for the same or similar elements.

DETAILED DESCRIPTION

Hereinafter, an electronic device according to various embodiments is described in greater detail with reference to accompanying drawings. The term "user" used in various embodiments may refer to a person using an electronic device or a device (for example, an artificial intelligence electronic device) using an electronic device.

FIG. **1** is a block diagram illustrating an electronic device **101** in a network environment **100** according to various embodiments. Referring to FIG. **1**, the electronic device **101** in the network environment **100** may communicate with an electronic device **102** via a first network **198** (e.g., a short-range wireless communication network), or an electronic device **104** or a server **108** via a second network **199** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **101** may communicate with the electronic device **104** via the server **108**. According to an embodiment, the electronic device **101** may include a processor **120**, memory **130**, an input module **150**, a sound output module **155**, a display module **160**, an audio module **170**, a sensor module **176**, an interface **177**, a connecting terminal **178**, a haptic module **179**, a camera module **180**, a power management module **188**, a battery **189**, a communication module **190**, a subscriber identification module (SIM) **196**, or an antenna module **197**. In various embodiments, at least one of the components (e.g., the connecting terminal **178**) may be omitted from the electronic device **101**, or one or more other components may be added in the electronic device **101**. In various embodiments, some of the components (e.g., the sensor module **176**, the camera module **180**, or the antenna module **197**) may be implemented as a single component (e.g., the display module **160**).

The processor **120** may execute, for example, software (e.g., a program **140**) to control at least one other component (e.g., a hardware or software component) of the electronic device **101** coupled with the processor **120**, and may perform various data processing or computation. According to an embodiment, as at least part of the data processing or computation, the processor **120** may store a command or data received from another component (e.g., the sensor module **176** or the communication module **190**) in volatile memory **132**, process the command or the data stored in the volatile memory **132**, and store resulting data in non-volatile memory **134**. According to an embodiment, the processor **120** may include a main processor **121** (e.g., a central processing unit (CPU) or an application processor (AP)), or an auxiliary processor **123** (e.g., a graphics processing unit (GPU), a neural processing unit (NPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **121**. For example, when the electronic device **101** includes the main processor **121** and the auxiliary processor **123**, the auxiliary processor **123** may be adapted to consume less power than the main processor **121**, or to be specific to a specified function. The auxiliary processor **123** may be implemented as separate from, or as part of the main processor **121**.

The auxiliary processor **123** may control, for example, at least some of functions or states related to at least one component (e.g., the display module **160**, the sensor module **176**, or the communication module **190**) among the components of the electronic device **101**, instead of the main processor **121** while the main processor **121** is in an inactive (e.g., sleep) state, or together with the main processor **121** while the main processor **121** is in an active (e.g., executing an application) state. According to an embodiment, the auxiliary processor **123** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **180** or the communication module **190**) functionally related to the auxiliary processor **123**. According to an embodiment, the auxiliary processor **123** (e.g., the neural processing unit) may include a hardware structure specified for artificial intelligence model processing. An artificial intelligence model may be generated by machine learning. Such learning may be performed, e.g., by the electronic device **101** where the artificial intelligence is performed or via a separate server (e.g., the server **108**). Learning algorithms may include, but are not limited to, e.g., supervised learning, unsupervised learning, semi-supervised learning, or reinforcement learning. The artificial intelligence model may include a plurality of artificial neural network layers. The artificial neural network may be a deep neural network (DNN), a convolutional neural network (CNN), a recurrent neural network (RNN), a restricted boltzmann machine (RBM), a deep belief network (DBN), a bidirectional recurrent deep neural network (BRDNN), deep Q-network or a combination of two or more thereof but is not limited thereto. The artificial intelligence model may, additionally or alternatively, include a software structure other than the hardware structure.

The memory **130** may store various data used by at least one component (e.g., the processor **120** or the sensor module **176**) of the electronic device **101**. The various data may include, for example, software (e.g., the program **140**) and input data or output data for a command related thereto. The memory **130** may include the volatile memory **132** or the non-volatile memory **134**.

The program **140** may be stored in the memory **130** as software, and may include, for example, an operating system (OS) **142**, middleware **144**, or an application **146**.

The input module **150** may receive a command or data to be used by another component (e.g., the processor **120**) of the electronic device **101**, from the outside (e.g., a user) of the electronic device **101**. The input module **150** may include, for example, a microphone, a mouse, a keyboard, a key (e.g., a button), or a digital pen (e.g., a stylus pen).

The sound output module **155** may output sound signals to the outside of the electronic device **101**. The sound output module **155** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record. The receiver may be used for receiving incoming calls. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

The display module **160** may visually provide information to the outside (e.g., a user) of the electronic device **101**. The display module **160** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display module **160** may include a touch sensor adapted to detect a touch, or a pressure sensor adapted to measure the intensity of force incurred by the touch.

The audio module **170** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **170** may obtain the sound via the input module **150**, or output the sound via the sound output module **155** or an external electronic device (e.g., an electronic device **102** (e.g., a speaker or a headphone)) directly or wirelessly coupled with the electronic device **101**.

The sensor module **176** may detect an operational state (e.g., power or temperature) of the electronic device **101** or an environmental state (e.g., a state of a user) external to the electronic device **101**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **176** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **177** may support one or more specified protocols to be used for the electronic device **101** to be coupled with the external electronic device (e.g., the electronic device **102**) directly or wirelessly. According to an embodiment, the interface **177** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

A connecting terminal **178** may include a connector via which the electronic device **101** may be physically connected with the external electronic device (e.g., the electronic device **102**). According to an embodiment, the connecting terminal **178** may include, for example, an HDMI connector, a USB connector, an SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **179** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **179** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **180** may capture a still image or moving images. According to an embodiment, the camera module **180** may include one or more lenses, image sensors, image signal processors, or flashes.

The power management module **188** may manage power supplied to the electronic device **101**. According to an embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

The battery **189** may supply power to at least one component of the electronic device **101**. According to an embodiment, the battery **189** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **190** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **101** and the external electronic device (e.g., the electronic device **102**, the electronic device **104**, or the server **108**) and performing communication via the established communication channel. The communication module **190** may include one or more communication processors that are operable independently from the processor **120** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **190** may include a wireless communication module **192** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **194** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device **104** via the first network **198** (e.g., a short-range communication network, such as Bluetooth™, wireless-fidelity (Wi-Fi) direct, or infrared data association (IrDA)) or the second network **199** (e.g., a long-range communication network, such as a legacy cellular network, a 5G network, a next-generation communication network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **192** may identify or authenticate the electronic device **101** in a communication network, such as the first network **198** or the second network **199**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the subscriber identification module **196**.

The wireless communication module **192** may support a 5G network, after a 4G network, and next-generation communication technology, e.g., new radio (NR) access technology. The NR access technology may support enhanced mobile broadband (eMBB), massive machine type communications (mMTC), or ultra-reliable and low-latency communications (URLLC). The wireless communication module **192** may support a high-frequency band (e.g., the mmWave band) to achieve, e.g., a high data transmission rate. The wireless communication module **192** may support various technologies for securing performance on a high-frequency band, such as, e.g., beamforming, massive multiple-input and multiple-output (massive MIMO), full dimensional MIMO (FD-MIMO), array antenna, analog beam-forming, or large scale antenna. The wireless communication module **192** may support various requirements specified in the electronic device **101**, an external electronic device (e.g., the electronic device **104**), or a network system (e.g., the second network **199**). According to an embodiment, the wireless communication module **192** may support a peak data rate (e.g., 20 Gbps or more) for implementing 1 eMBB, loss coverage (e.g., 164 dB or less) for implementing mMTC, or U-plane latency (e.g., 0.5 ms or less for each of downlink (DL) and uplink (UL), or a round trip of 1 ms or less) for implementing URLLC.

The antenna module **197** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **101**. According to an embodiment, the antenna module **197** may include an antenna including a radiating element including a conductive material or a conductive pattern formed in or on a substrate (e.g., a printed circuit board (PCB)). According to an embodiment, the antenna module **197** may include a plurality of antennas (e.g., array antennas). In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **198** or the second network **199**, may be selected, for example, by the communication module **190** from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **190** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **197**.

According to various embodiments, the antenna module **197** may form a mmWave antenna module. According to an embodiment, the mmWave antenna module may include a printed circuit board, an RFIC disposed on a first surface (e.g., the bottom surface) of the printed circuit board, or adjacent to the first surface and capable of supporting a designated high-frequency band (e.g., the mmWave band), and a plurality of antennas (e.g., array antennas) disposed on a second surface (e.g., the top or a side surface) of the printed circuit board, or adjacent to the second surface and capable of transmitting or receiving signals of the designated high-frequency band.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **101** and the external electronic device **104** via the server **108** coupled with the second network **199**. Each of the external electronic devices **102** or **104** may be a device of a same type as, or a different type, from the electronic device **101**. According to an embodiment, all or some of operations to be executed at the electronic device **101** may be executed at one or more of the external electronic devices **102**, **104**, or **108**. For example, if the electronic device **101** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **101**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **101**. The electronic device **101** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, mobile edge computing (MEC), or client-server computing technology may be used, for example. The electronic device **101** may provide ultra low-latency services using, e.g., distributed computing or mobile edge computing. In an embodiment, the external electronic device **104** may include an internet-of-things (IoT) device. The server **108** may be an intelligent server using machine learning and/or a neural network. According to an embodiment, the external electronic device **104** or the server **108** may be included in the second network **199**. The electronic device **101** may be applied to intelligent services (e.g., smart home, smart city, smart car, or healthcare) based on 5G communication technology or IoT-related technology.

FIG. **2** is a block diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment, and FIG. **3** is a block diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment.

Referring to FIGS. **2** and **3**, according to an embodiment, an electronic device (e.g., the electronic device **101** of FIG. **1**) may include a wireless communication module **200** (e.g., the wireless communication module **192** of FIG. **1**) supporting a first communication scheme and a second communication scheme and processor (e.g., e.g., the processor **120** of FIG. **1** and including processing circuitry).

According to an embodiment, the wireless communication module **200** may include a radio frequency processing module (e.g., including a radio frequency integrated circuit (RFIC)) **210**, a first power amplification circuit **220**, a second power amplification circuit **230**, a front-end module (e.g., front-end module with integrated duplexers ((L) FEMiD) **240**, and/or an antenna **250**. The wireless communication module **200** may include, but is not limited to, a device for processing a radio signal, and may further include elements for processing reception of a radio signal. The wireless communication module **200** may support both the first communication scheme and the second communications scheme to perform wireless communication in a scheme (e.g., an E-UTRAN new radio dual connectivity (ENDC) scheme) for increasing a data transmission rate, and may selectively perform first communication in the first communication scheme and second communication in the second communication scheme as necessary. For example, the first communication scheme may correspond to a 5G (e.g., NR) communication scheme, and the second communication scheme may correspond to a 4G (e.g., LTE) communication scheme. According to an embodiment, a frequency band of the first communication scheme may use a broader broadband and a higher frequency band, compared to a frequency band of the second communication scheme. A part (a part of a mid band) of the frequency band of the second communication scheme is used in the first communication scheme and two frequency bands may partially overlap, and thus two frequency bands may be configured to be selectively used.

According to an embodiment, the radio frequency processing module **210** may include a radio frequency integrated circuit (RFIC) and may correspond to an RF circuit for wireless communication, may perform signal processing for transmission/reception of a radio signal, and may be controlled by at least one processor (e.g., the processor **120** of FIG. **1**) of the electronic device **101**. The at least one processor (e.g., the processor **120** of FIG. **1**) of the electronic device **101** may be connected to each of the first power amplification circuit **220** and the second power amplification circuit **230** to control operations of the first power amplification circuit **220** and the second power amplification circuit **230**. The radio frequency processing module **210** may output a transmission signal to each of the first power amplification circuit **220** and the second power amplification circuit **230**.

The radio frequency processing module **210** may process a frequency band which is to transmit a transmission signal, based on a combination of frequency bands of the first communication scheme and the second communication scheme. Each of the first power amplification circuit **220** and the second power amplification circuit **230** may include, for example, a multimode multiband (MMMB)-type power amplifier.

According to an embodiment, the processor may include various processing circuitry and control the same frequency band, as necessary, to use one of different frequency bands for first communication by the first communication scheme and the other for second communication by the second communication scheme, based on a combination of frequency bands for the first communication scheme and the second communication scheme (e.g., a E-UTRAN new radio dual connectivity (ENDC) type combination).

According to an embodiment, the first power amplification circuit **220** may be electrically connected to the radio frequency processing module **210** and the second power amplification circuit **230**, and may include at least one power amplifier **221** which amplifies at least one signal output from the radio frequency processing module **210**. According to an embodiment, the first power amplification circuit **220** may be configured to connect at least one input port to at least one output port of the radio frequency processing module **210** and connect at least one output port to the second power amplification circuit **230**.

According to an embodiment, as shown in FIG. **3**, the first power amplification circuit **220** may include at least one power amplifier **221** which amplifies at least one signal input from the radio frequency processing module **210**. The first power amplification circuit **220** may be configured to output at least one amplified signal output from at least one first power amplifier **221**, to the second power amplification circuit through at least one output port **311**. The at least one output port **311** may be configured to be connected to an input terminal of a switch **233** included in the second power amplification circuit. For example, as shown in FIG. **3**, the first power amplification circuit **220** may connect one output port to an input port of a first switch **301** included in a switch module **233** of the second power amplification circuit **230**.

According to an embodiment, as shown in FIG. **3**, the first power amplification circuit **220** may not include a switch electrically connected to an output terminal of the first power amplifier **221**, and may be configured to connect an output port **311** to an input terminal of the switch module **233** of the second power amplification circuit **230** so that an amplified signal (e.g., a first signal) output from the first power amplifier **221** is input to the second power amplification circuit **230**. For example, the first power amplification circuit **220** may support both the first communication scheme and the second communication scheme, and may support at least one of frequency bands (e.g., LB, MB, and HB).

According to an embodiment, the second power amplification circuit **230** may be configured to be electrically connected to the radio frequency processing module **210**, the first power amplification circuit **220**, and the front-end module **240**. The second power amplification circuit **230** may acquire, from the first power amplification circuit **220**, a first signal obtained by amplifying a signal output from the radio frequency processing module **210**, and acquire a second signal by amplifying a signal output from the radio frequency processing module **210**, based on a combination of frequency bands for the first communication scheme and the second communication scheme. The second power amplification circuit **230** may be configured to switch at least one of the first signal or the second signal to the at least one output port connected to the front-end module **240**, based on the first frequency band of the first signal and the second frequency band of the first signal. The second power amplification circuit **230** may support the first communication scheme and/or the second communication scheme.

According to an embodiment, as shown in FIG. **3**, the second power amplification circuit **230** may include the second power amplifier **231** which amplifies a signal input from the radio frequency processing module **210**, and the switch module **233** connected to an output terminal of the second power amplifier **231** and an output terminal of the first power amplification circuit **220**. The wireless communication module **200** may acquire the second signal by amplifying a signal input from the radio frequency processing module **210**, using the second power amplifier **231**.

According to an embodiment, the second power amplification circuit **230** may include the second power amplifier **231** or a third power amplifier (not shown) to amplify signals in two or more different frequency bands.

According to an embodiment, the switch module **233** may switch signals amplified from the first power amplifier **221** or the second power amplifier **231** to an output port (e.g., the output ports **311** and **315** of FIG. **3**) of a frequency band corresponding to the switch module **233** and connect the same to the front-end module **240**. The switch module **233** may be disposed in the form of a double-pole n throw (DPnT) switch including multiple switches **301** and **303**.

According to an embodiment, the front-end module **240** may be configured to be connected to the second power amplification circuit **230** and the antenna **250**. The front-end module **240** may transfer at least one signal output from the second power amplification circuit **230** to the antenna **250** to transmit the same through the antenna **250**. The front-end module **240** may include a duplex (not shown) connected to the antenna **250**. For example, the front-end module **240** may be configured to transmit at least one of the first signal or the second signal input through the at least one connected output port to the outside through the antenna **250**.

According to an embodiment, the wireless communication module **200** of the electronic device **101** may include power supply modules (not shown) for supplying power to the first power amplification circuit **220** and the second power amplification circuit **230**.

Referring to FIG. **3**, according to an embodiment, each of the first power amplification circuit **220** and the second power amplification circuit **230** of the wireless communication module **200** may receive a signal to transmit, from the radio frequency processing module **210**, based on a combination of frequency bands. For example, the combination of the frequency bands may be configured with a combination of any one of frequency bands (e.g., LB, MB, and HB) of the first communication scheme and any one of frequency bands (e.g., LB, MB, and HB) of the second communication scheme. For example, the combination of the frequency bands may be configured as shown in <Table 1> below, which corresponds to description as one example for convenience of description, and is not limited thereto and may be configured with another combination according to a business operator, a service, and the like. For example, in <Table 1> below, LB/MB ENDC may indicate a low band (e.g., supporting LTE ANCHOR) and a mid band (e.g., supporting NR SUB 6), and MB/HB ENDC may indicate a mid band (e.g., supporting LTE ANCHOR) and a high band (e.g., supporting NR SUB 6). NR MMMB #1 may indicate the first power amplification circuit **220**, and NR MMMB #2 may indicate the second power amplification circuit **230**.

TABLE 1

LB/MB ENDC	MB/HB ENDC	
NR MMMB #2: B28NR MMMB #1: N1	NR MMMB #2: B1 NR MMMB #1: N41	
LB/MB ENDC	MB/HB ENDC	
NR MMMB #2: B28NR MMMB #1: N3	NR MMMB #2: B3 NR MMMB #1: N41	
MB/LB ENDC	LB/HB ENDC	MB/HB ENDC
NR MMMB #2: B1 NR MMMB #1: N28	NR MMMB #2: B28 NR MMMB #1: N41	NR MMMB #2: B1 NR MMMB #1: N41

According to an embodiment, the first power amplification circuit **220** of the wireless communication module **200** may amplify a first signal received from the radio frequency processing module **210**, through the first power amplifier **221**, and input the amplified signal to the first switch **301** of the switch module **233** of the second power amplification circuit **230**. The first power amplification circuit **220** may include at least one output port which outputs a signal in at a frequency band (e.g., at least one of an NR low band (LB), an NR mid band (MB), or an NR high band (HB)) of the first communication scheme. For example, the first power amplification circuit **220** may output the first signal from one of ports in frequency bands (NR low band (LB) and NR mid band (MB)) of the first communication scheme. For example, the first signal may be a signal in a frequency band (e.g., NR LB or NR MB) of the first communication scheme.

According to an embodiment, the second power amplification circuit **230** may amplify a second signal received from the radio frequency processing module **210**, through the power amplifier **231**, and may input the amplified second signal to the second switch **303** of the switch module **233**. The second power amplification circuit **230** may support, for example, LMB ENDC (LB: LTE anchor, MB: NR sub 6). According to an embodiment, the first power amplification circuit **220** and the second power amplification circuit **230** support LTE/NR, and thus, the first power amplification circuit **220** may operate in LTE, and the second power amplification circuit **230** may operate in NR.

According to an embodiment, the switch module **233** of the second power amplification circuit **230** may switch the first switch **301** and the second switch **303** to connect the same to the first output port **313** and the second output port **315** connected to the front-end module **240**, and may output the first signal and/or the second signal to the front-end module **240** through the first output port **313** and/or the second output port **315**. For example, the second power amplification circuit **230** may switch the first switch **301**, based on a frequency band (e.g., N1 (1920 to 1989 MHz)) of the input first signal, to output the first signal to the front-end module **240** through an output port (e.g., the output port **313** of FIG. **3**) corresponding to the frequency band (e.g., N1 (1920 to 1989 MHz). For example, the second power amplification circuit **230** may switch the second switch **303**, based on a frequency band (e.g., B3 (1710 to 1780 MHz)) of the input second signal, to output the second signal to the front-end module **240** through an output port (e.g., the output port **315** of FIG. **3**) corresponding to the frequency band (e.g., B3 (1710 to 1780 MHz)). For example, when the frequency band of the first signal corresponds to a mid band (MB), and the frequency band of the second signal corresponds to a low band (LB), the second power amplification circuit **230** may output the first signal to the front-end module **240** through the first output port **313** using the first switch **301**, and may output the second signal to the front-end module **240** through the second output port **315** using the second switch **303**.

According to an embodiment, the front-end module **240** may transmit the first signal and the second signal simultaneously input through the first output port **311** and the second output port **313** of the second power amplification circuit **230**, respectively, to the antenna **250**. For example, when the frequency bands of the first signal and the second signal are identical, the front-end module **240** may selectively transmit the input first signal or second signal to the antenna **250**.

FIGS. **4**A and **4**B are diagrams illustrating example configurations of a wireless communication module of an electronic device according to an embodiment.

Referring to FIG. **4**A, according to an embodiment, the first power amplification circuit **220** of the wireless communication module **200** may include input ports of two frequency bands (e.g., LB and MB) of a first communication scheme, the input ports being connected to the radio frequency processing module **210**, and output ports **401** and **403** (e.g., an NR LB output port and an NR MB output port) of two frequency bands (e.g., LB and MB). The first power amplification circuit **220** may include power amplifier **221***a* and **221***b* for amplifying signals, respectively, the signal being received from the input ports of two frequency bands (e.g., LB and MB). The first power amplification circuit **220** may input a first signal (e.g., NR MB) and a third signal (e.g., NR LB) amplified by the power amplifiers **221***a* and **221***b* to input ports **421** and **423** of the switch modules **233***a* and **233***b* of the second power amplification circuit **230** through the output ports **401** and **403** of two frequency bands (e.g., LB and MB).

In an embodiment, the switch modules **233***a* and **233***b* may include a first switch module **233***a* and a second switch module **233***b*. The first switch module **233***a* may include a first switch **411** and a second switch **412**. The second switch module **233***b* may include a third switch **413** and a fourth switch **414**.

In an embodiment, the first power amplification circuit **220** may include a (1-1)th power amplifier **221***a* and a (1-2)th power amplifier **221***b*. For example, the (1-1)th power amplifier **221***a* may amplify a signal of a frequency band of the first signal. In another example, the (1-2)th power amplifier **221***b* may amplify a signal of a frequency band of the third signal. In an embodiment, the second power amplification circuit **230** may include a (2-1)th power amplifier **231***a* and a (2-2)th power amplifier **231***b*. For example, the (2-1)th power amplifier **231***a* may amplify a signal of a frequency band of the second signal. In another example, the (2-2)th power amplifier **231***b* may amplify a signal of a frequency band of the fourth signal.

According to an embodiment, the second power amplification circuit **230** may include input ports of two frequency bands (e.g., LB and MB) connected to the radio frequency processing module **210**, the power amplifiers **231***a* and **231***b*, and/or switch modules **233***a* and **233***b* electrically connected to the power amplifiers **231***a* and **231***b*. The second power amplification circuit **230** may include multiple output ports which connect the switch modules **233***a* and **233***b* to the front-end module **240** by switching operation of the switch modules **233***a* and **233***b*. The power amplifiers **231***a* and **231***b* may amplify signals input from the input ports to output the amplified signals (e.g., the second signal and/or the fourth signal) to the switch modules **233***a* and **233***b*. As shown in FIG. **4**A, the switch modules **233***a* and **233***b* of the second power amplification circuit **230** may be formed in the form of DPnT, but is not limited thereto, and may be formed, as shown in FIG. **4**B, in the form of 4PNT SW, and the structure of the SW form may not be limited.

Referring to FIG. **4**A, according to an embodiment, the second switch module **233***b* of the second power amplification circuit **230** may receive, from the radio frequency processing module **210**, an input of the first signal (e.g., an NR MB signal) amplified through the first power amplification circuit **220**, and an input of the second signal (e.g., an MB signal) output from the $(2\text{-}2)^{th}$ power amplifier **231***b*, based on a combination of frequency bands. The second switch module **233***b* may switch at least one of the first signal or the second signal to at least one output port connected to the front-end module **240**, based on the first frequency band (e.g., NR MB) of the first communication scheme of the first signal and the second frequency band (e.g., MB) of the second communication scheme of the second signal. For example, when the first frequency band (e.g., NR MB) of the first communication scheme and the second frequency band (e.g., MB) of the second communication scheme correspond to a second band (e.g., N1) and a third band (e.g., B3) which are different from each other, the second switch module **233***b* may switch the fourth switch **414** to a second output port **432** corresponding to the second band (e.g., N1) to output the first signal to the front-end module **240** through the second output port **432**, and may switch the third switch **413** to a third output port **433** corresponding to the third band (e.g., B3) to output the second signal to the front-end module **240** through the third output port **433**. For example, when the first frequency band (e.g., NR MB) of the first communication scheme and the second frequency band (e.g., MB) of the second communication scheme correspond to the same third band (e.g., N3 and B3), the second switch module **233***b* may configure the fourth switch **414** to be switched on and the third switch **413** to be switched off, and may switch the fourth switch **414** to the third output port **433** corresponding to the third band to output the first signal. In another example, the second switch module **233***b* may configure the fourth switch **414** to be switched off and the third switch **413** to be switched on, and may switch the third switch **413** to the third output port **433** to output the second signal.

Referring to FIG. **4**A, according to an embodiment, the first switch module **233***a* of the second power amplification circuit **230** may receive, from the radio frequency processing module **210**, an input of a third signal (e.g., an NR LB signal) amplified through the first power amplification circuit **220** and an input of a fourth signal (e.g., an LB signal) output from the $(2\text{-}1)^{th}$ power amplifier **231***a*, based on a combination of frequency bands. The first switch module **233***a* may switch at least one of the third signal or the fourth signal to a corresponding output port connected to the front-end module **240**, based on a third frequency band (e.g., NR LB) of the first communication scheme of the third signal and a fourth frequency band (e.g., LB) of the second communication scheme of the fourth signal. For example, when the third frequency band (e.g., NR LB) of the first communication scheme and the fourth frequency band (e.g., LB) of the second communication scheme correspond to the same first band (e.g., N28 and B28), the first switch module **233***a* may configure the first switch **411** to be switched on and the second switch **412** to be switched off, and may switch the first switch **411** to the first output port **431** corresponding to the first band to output the third signal. In another example, the first switch module **233***a* may configure the first switch **411** to be switched off and the second switch **412** to be switched on, and may switch the second switch **412** to the first output port **431** corresponding to the first band to output the fourth signal.

For example, when the third frequency band (e.g., NR LB) of the first communication scheme and the second frequency band (e.g., LB) of the second communication scheme correspond to a first band (e.g., N28) and a second band (e.g., B1) which are different from each other, the first switch module **233***a* may switch the first witch **411** to the first output port **431** corresponding to the first band (e.g., N28) to output the third signal to the front-end module **240**, and may switch the second switch **412** to the second output port **432** corresponding to the second band (e.g., B1) to output the fourth signal to the front-end module **240**.

Referring to FIG. **4**B, according to an embodiment, the second power amplification circuit **230** may include a switch module **410** so that the switch module **410** includes 4PNT-type four switches **411**, **412**, **413**, and **414**. For example, when the frequency band combination corresponds to a B1+N28 ENDC combination, the first switch **411** connected to an output terminal of the first power amplification circuit **220** is switched on and the third switch **413** connected to an output terminal of the $(2\text{-}2)^{th}$ power amplifier **231***b* is switched on, and thus, the second power amplification circuit **230** may output the N28 first signal (e.g., an NR MB signal) and the B1 fourth signal (e.g., an LB signal). In another example, when the frequency band combination corresponds to a B28+N1 ENDC combination, the fourth switch **414** connected to an output port of the first power amplification circuit **220** is switched on and the second switch **412** connected to an output terminal of the $(2\text{-}1)^{th}$ power amplifier **231***a* is switched on, and thus, the second power amplification circuit **230** may output the B28 fourth signal (e.g., an LB signal) and the N1 fourth signal (e.g., an NR LB signal). As shown in FIG. **4**B, the switch module **410** having a 4PNT switch structure does not need to use each of B1 SPDT SWITCH and B28 SPDT SW, and thus the size and a implementation cost of a wireless communication module of an electronic device can be reduced.

FIG. **5** is a diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment.

Referring to FIG. **5**, according to an embodiment, the first power amplification circuit **220** of the wireless communication module **200** may include input ports of three frequency bands (e.g., LB, MB, and HB) of the first communication scheme, the input ports being connected to the radio frequency processing module **210**, and output ports **501**, **503**, and **505** (e.g., NR LB, NR MB, and NR HB output ports) corresponding to three frequency bands (e.g., LB, MB, and HB). The first power amplification circuit **220** may include power amplifiers **221***a*, **221***b*, and **221***c* for amplifying signals (e.g., NR LB, NR MB, and NR HB signals), respectively, the signals being received from the input ports of three frequency bands (e.g., LB, MB, and HB). The first power amplification circuit **220** may input signals amplified by the power amplifiers **221***a*, **221***b*, and **221***c* to input ports **521**, **523**, and **525** (e.g., NR LB, NR MB, and NR HB input ports) of a second power amplification circuit **230** through the output ports **501**, **503**, and **505** (e.g., NR LB, NR MB, and NR HB output ports) of three frequency bands (e.g., LB, MN, and HB).

According to an embodiment, the first power amplification circuit **220** may include a $(1\text{-}1)^{th}$ power amplifier **221***a*, a (1-2)th power amplifier **221***b*, and a (1-3)th power amplifier **221***c*. In an embodiment, the second power amplification circuit **230** may include a (2-1)th power amplifier **231***a*, a (2-2)th power amplifier **231***b*, and a (2-3)th power amplifier **231***c*.

According to an embodiment, the second power amplification circuit **230** may include input ports of three frequency bands (LB, MB, and HB) of the first communication scheme, the input ports being connected to the radio frequency processing module **210**, power amplifiers **231***a*, **231***b* and **231***c* for amplifying signals, respectively, the signals being received from three input ports, and/or switch modules **233***a*, **233***b*, and **233***c* connected to the power amplifiers **231***a*, **231***b* and **231***c*. The second power amplification circuit **230** may include multiple output ports which connect the switch modules **233***a*, **233***b*, and **233***c* to the front-end module **240** by switching operation of the switch modules **233***a*, **233***b*, and **233***c*.

According to an embodiment, the switch modules **233***a*, **233***b*, and **233***c* may include a first switch module **233***a*, a second switch module **233***b*, and a third switch module **233***c*. For example, the first switch module **233***a* may be electrically connected to the (1-1)th power amplifier **221***a* and the (2-1)th power amplifier **231***a*. In another example, the second switch module **233***b* may be electrically connected to the (1-2)th power amplifier **221***b* and the (2-2)th power amplifier **231***b*. In another example, the third switch module **233***c* may be electrically connected to the (2-3)th power amplifier **233***c*.

According to an embodiment, at least one of the first switch module **233***a*, the second switch module **233***b*, and/or the third switch module **233***c* may electrically connect the front-end module **240** to at least one of the (1-1)th power amplifier **221***a*, the (1-2)th power amplifier **221***b*, the (1-3)th power amplifier **221***c*, the (2-1)th power amplifier **231***a*, the (2-2)th power amplifier **231***b*, and the (2-3)th power amplifier **231***c*, based on a frequency band combination in the ENDC situation.

FIG. **6** is a diagram illustrating an example configuration of a wireless communication module of an electronic device according to an embodiment.

Referring to FIG. **6**, according to an embodiment, all of the first power amplification circuit **220** and the second power amplification circuit **230** of the wireless communication module **200** may be configured not to include a switch, and an SW module for switching operation of each frequency band may be included in the front-end module **240**. In an embodiment, the first power amplification circuit **220** may not include a switch module, and include power amplifiers **221***a* and **221***b* of two frequency bands (e.g., MB and LB) and output ports **611** and **613**. In an embodiment, the second power amplification circuit **230** may not include a switch module, and include power amplifiers **231***a* and **231***b* of two frequency bands (e.g., MB and LB) and output ports **621** and **623**. The front-end module **240** may include a first switch module **601** for receiving a first signal (LB) output from the first power amplification circuit **220** and a second signal (e.g., an LB signal) output from the second power amplification circuit **230** through the input ports **631** and **632** and switching the received first signal and second signal, and a second switch module **603** for receiving a third signal (e.g., an MB signal) output from the first power amplification circuit **220** and a fourth signal (e.g., an LB signal) output from the second power amplification circuit **230** through the input ports **633** and **634** and switching the received third signal and fourth signal. The front-end module **240** may transmit signals output from the first switch module **601** and the second switch module **603**, through the antenna **250**.

As shown in FIG. **6**, output structures of the first power amplification circuit **220** and the second power amplification circuit **230** may be simple so as to use one port for each of the first frequency band (e.g., LB) and the second frequency band (e.g., MB), an SPDT switch for the same frequency band does not need to be used, and additionally, a line loss of a path of each of frequency bands between power amplification circuits **220** and **230** and the front-end module **240** can be reduced.

Accordingly, in an embodiment, main elements of an electronic device are described with reference to the electronic device **101** of FIGS. **1** and **2**. However, in various embodiments, the elements illustrated in FIGS. **1** and **2** are not necessary, and more elements than the illustrated elements may be implemented by the electronic device **101**, and fewer elements that the illustrated elements may be implemented by the electronic device **101**. In addition, locations of the main elements of the electronic device **101** described above with reference to FIGS. **1** and **2** are changeable according to various embodiments.

According to an embodiment, an electronic device (e.g., the electronic device **101** of FIGS. **1** and **2**) for electronic device wireless communication may include: a radio frequency processing module comprising radio frequency circuitry (e.g., the radio frequency processing module **210** of FIGS. **2**, **4**A, **4**B, **5**, and **6**), a first power amplification circuit (e.g., the first power amplification circuit **220** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) connected to the radio frequency processing module, a second power amplification circuit (e.g., the second power amplification circuit **230** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) connected to the radio frequency processing module and the first power amplification circuit, and a front-end module (e.g., the front-end module **240** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) comprising circuitry connected to the second power amplification circuit and an antenna and configured to transmit a signal, wherein the second power amplification circuit is configured to: acquire, from the first power amplification circuit, a first signal obtained by amplifying a signal output from the radio frequency processing module and a second signal obtained by amplifying a signal output from the radio frequency processing module, based on a combination of frequency bands for a first communication scheme and a second communication scheme, and switch at least one of the first signal or the second signal to at least one output port connected to the front-end module, based on a first frequency band of the first signal and a second frequency band of the second signal.

According to an embodiment, the front-end module may be configured to transmit at least one of the first signal or the second signal input through the connected at least one output port, in at least one of the first frequency band or the second frequency band through the antenna.

According to an embodiment, the first communication scheme may correspond to a 5G communication scheme, and the second communication scheme may correspond to a 4G communication scheme.

According to an embodiment, the first power amplification circuit may include at least one power amplifier (e.g., the power amplifiers **221** and **231** of FIG. **3**, power amplifiers **221***a*, **221***b*, **223***a*, and **223***b* of FIGS. **4**A, **4**B, and **6**, and the power amplifiers **221***a*, **221***b*, **221***c*, **223***a*, **223***b*, and **223***c* of FIG. **5**) configured to amplify at least one signal input from the radio frequency processing module, and may be configured to output at least one signal output from the at least one power amplifier, to the second power amplification circuit through at least one output port connected to the second power amplification circuit, wherein the at least one amplified signal includes the first signal of the first communication scheme.

According to an embodiment, the second power amplification circuit may include at least one power amplifier configured to amplify at least one signal input from the radio frequency processing module, and a switch module (e.g., the switch module **233** of FIG. **3**, the switch modules **233***a* and **233***b* of FIGS. **4**A and **4**B, and the switch modules **233***a*, **233***b*, and **233***c* of FIG. **5**) comprising at least one switch configured to switch at least one signal output from the at least one power amplifier and at least one signal output from the first power amplifier. The switch module may include at least one switch (e.g., the switches **411** and **414** of FIGS. **4**A and **4**B) connected to at least one output port of the first power amplification circuit and at least one switch (e.g., the switches **412** and **413** of FIGS. **4**A and **4**B) connected to at least one amplifier of the second power amplification circuit, and the at least one amplified signal may include the second signal.

According to an embodiment, the switch module may be configured to switch the first signal to a first output port among the least one output port to transmit the first signal, and switch the second signal to a second output port among the at least one output port to transmit the second signal, wherein the first frequency band and the second frequency band may be different frequency bands.

According to an embodiment, the switch module may be configured to switch one of the first signal or the second signal to one of the at least one output port based on the first frequency band being identical to the second frequency band.

According to an embodiment, the front-end module may include a switch module (e.g., the first switch module **601** and the second switch module **602** of FIG. **6**) comprising at least one switch configured to switch at least one signal output from at least one of the first power amplification circuit or the second power amplification circuit.

According to an embodiment, based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, the switch module may be configured to switch the first signal to a first output port among output ports of the front-end module connected to the antenna, and switch the second signal to a second output port among the output ports of the front-end module, wherein the first frequency band may be different from the second frequency band.

According to an embodiment, the switch module may be configured to switch one of the first signal or the second signal to one of the output ports of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, wherein the first frequency band may be identical to the second frequency band.

According to an embodiment, the electronic device may further include a processor (e.g., the processor **120** of FIGS. **1** and **2**) electrically connected to the radio frequency processing module and configured to control operations of the first power amplification circuit and the second power amplification circuit.

FIG. **7** is a flowchart illustrating an example method **700** of operating an electronic device according to an embodiment.

An electronic device (e.g., the electronic device **101** of FIGS. **1** and **2**) according to an embodiment may perform a method **700** for wireless communication in a wireless communication module (e.g., the wireless communication module **192** of FIG. **1** and the wireless communication module **200** of FIG. **2**) supporting a first communication scheme and a second communication scheme.

Referring to FIG. **7**, in operation **701**, the electronic device, by a processor (e.g., the processor **120** of FIG. **1**), may perform control to output a signal to a first power amplification circuit (e.g., the first power amplification circuit **220** of FIG. **3**) and a second power amplification circuit (e.g., the second power amplification circuit **230** of FIG. **3**) through a radio processing module (e.g., the radio frequency processing module **210** of FIG. **2**), based on a combination of frequency bands for the first communication scheme and the second communication scheme.

In operation **703**, the electronic device, by a processor, may amplify signals output from the first power amplification circuit and the second power amplification circuit to the radio frequency processing module. Each of the first power amplification circuit and the second power amplification circuit may include at least one power amplifier. The first power amplification circuit may support the first communication scheme and the second communication scheme, and may output a first signal obtained by amplifying a signal of the first communication scheme and/or the second communication scheme to an input terminal of the second power amplification circuit. The processor may control the second power amplification circuit to acquire the first signal from the first power amplification circuit and acquire a second signal obtained by amplifying a signal output from the radio frequency processing module.

In operation **705**, the electronic device, by the processor, may control the second power amplification circuit to switch at least one of the first signal or the second signal to at least one output port connected to the front-end module, based on the first frequency band of the first signal and the second frequency band of the second signal. The second power amplification circuit may support the first communication scheme and the second communication scheme, and may include a switch module (e.g., the switch module **233** of FIG. **3**). The second power amplification circuit may perform switching operation to simultaneously or selectively output the first signal of the first communication scheme and the second signal of the second communication scheme.

In operation **707**, the electronic device, by the processor, may control the front-end module to transmit at least one of the first signal or the second signal to at least one of the first frequency band or the second frequency band through the antenna.

In operation **705** above, when the first frequency band is different from the second frequency band, the processor may control the second power amplification circuit to switch the first signal to a first output port among at least one output port so as to transmit the first signal in the first frequency band, and to switch the second signal to a second output port among the least one output port so as to transmit the second signal in the second frequency band. When it is identified that the first frequency band and the second frequency band are designated as the same frequency band, the processor may control the second power amplification circuit to switch one of the first signal and the second signal to one of the at least one output port.

In operation **705**, as shown in FIGS. **4**A and **4**B, the second power amplification circuit of the wireless communication module may receive a third signal of the first communication scheme from the radio frequency processing module through the first power amplification circuit, based on a combination of frequency bands, and may receive a fourth signal of the second communication scheme from the radio frequency processing module, based on a combination of frequency bands. The second power amplification circuit may switch at least one of the third signal or the fourth signal to at least one output port connected to a front-end module, based on a third frequency band of the third signal and a fourth frequency band of the fourth signal. When the third frequency band and the fourth frequency band are designated as different frequency bands, the second power amplification circuit may switch the third signal to a third output port among the at least one output port so as to transmit the third signal in the third frequency band of the third signal, and switch the fourth signal to a fourth output port among the at least one output port so as to transmit the fourth signal in the fourth frequency band of the fourth signal. When the second power amplification circuit identifies that the third frequency band and the fourth frequency band are designated as the same frequency band, one of the third signal and the fourth signal may be switched to one of the at least one output port, by the second power amplification circuit.

According to an embodiment, a method for wireless communication in an electronic device (e.g., the electronic device **101** of FIGS. **1** and **2**) including a wireless communication module comprising communication circuitry (e.g., the wireless communication module **192** of FIG. **1** and the wireless communication module **200** of FIG. **2**) may include: amplifying a signal output from a radio frequency processing module comprising radio frequency circuitry (e.g., the radio frequency processing module **210** of FIGS. **2**, **4**A, **4**B, **5**, and **6**) of the wireless communication module, by a first power amplification circuit (e.g., the first power amplification circuit **220** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) of the wireless communication module, based on a combination of frequency bands for a first communication scheme and a second communication scheme, acquiring, as a first signal, an amplification signal output from the first power amplification circuit, and acquiring a second signal by amplifying a signal output from the radio frequency processing module, based on the combination of the frequency bands, by a second power amplification circuit (e.g., the second power amplification circuit **230** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) of the wireless communication module, and switching at least one of the first signal or the second signal to at least one output port connected to a front-end module (e.g., the front-end module **240** of FIGS. **2**, **3**, **4**A, **4**B, **5**, and **6**) of the wireless communication module, by the second power amplification circuit, based on a first frequency band of the first signal and a second frequency band of the second signal.

According to an embodiment, the method may further include transmitting at least one of the first signal or the second signal input through the at least one output port, through the antenna by the front-end module. The first communication scheme may correspond to a 5G communication scheme, and the second communication scheme may correspond to a 4G communication scheme.

According to an embodiment, the method may further include amplifying the first signal to be transmitted in the first frequency band of the first communication scheme, by the first power amplification circuit; and outputting the first signal upon an input of the second power amplification circuit.

According to an embodiment, the switching of at least one of the first signal or the second signal to the at least one of the output port connected to the front-end module of the wireless communication module may include switching, by the second power amplification circuit, the first signal to a first output port among the least one output port to transmit the first signal, and switching the second signal to a second output port among the at least one output port to transmit the second signal. The first frequency band may be different from the second frequency band.

According to an embodiment, the switching of at least one of the first signal or the second signal to the at least one output port connected to the front-end module of the wireless communication module may include switching one of the first signal or the second signal to one of the at least one output port based on the first frequency band being identical to the second frequency band.

According to an embodiment, the method may further include switching the first signal to a first output port among output ports of the front-end module connected to the antenna, and switching the second signal to a second output port among the output ports of the front-end module, by a switch module comprising a switch (e.g., the first switch module **601** and the switch module **603** of FIG. **6**) of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, wherein the first frequency band is different from the second frequency band.

According to an embodiment, the method may further include switching one of the first signal or the second signal to one of the output ports of the front-end module, by a switch module (e.g., the first switch module **601** and the second switch module **603** of FIG. **6**) of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, wherein the first frequency band may be identical to the second frequency band.

According to an embodiment, in a non-transitory storage medium storing a program, the program comprising executable instructions which, when executed by a processor of an electronic device, causes, the processor to: receive, by a second power amplification circuit of a wireless communication module comprising wireless communication circuitry, a first signal from a radio frequency processing module comprising radio frequency circuitry of the wireless communication module through a first power amplification circuit, based on a combination of frequency bands for a first communication scheme and a second communication scheme, receive a second signal from the radio frequency processing module by the second power amplification circuit, based on the combination of the frequency bands, and switch, by the second power amplification circuit, at least one of the first signal or the second signal to at least one output port connected to a front-end module of the wireless communication module, based on a first frequency band of the first signal and a second frequency band of the second signal.

The various example embodiments disclosed herein are provided to describe technical details of the disclosure and to aid in understanding of the disclosure, and are not intended to limit the scope of embodiments of the disclosure. Therefore, it should be understood that all modifications and changes or various other embodiments based on the technical idea of the disclosure fall within the scope of the disclosure.

The electronic device according to various embodiments disclosed herein may be one of various types of electronic devices. The electronic device may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, a home appliance, or the like. The electronic device according to an embodiment of the disclosure is not limited to those described above.

It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as “A or B,” “at least one of A and B,” “at least one of A or B,” “A, B, or C,” “at least one of A, B, and C,” and “at least one of A, B, or C,” may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as “1st” and “2nd,” or “first” and “second” may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term “operatively” or “communicatively”, as “coupled with,” “coupled to,” “connected with,” or “connected to” another element (e.g., a second element), the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

As used in connection with various embodiments of the disclosure, the term “module” may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, “logic,” “logic block,” “part,” or “circuitry”. A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

Various embodiments as set forth herein may be implemented as software (e.g., the program **140**) including one or more instructions that are stored in a storage medium (e.g., internal memory **136** or external memory **138**) that is readable by a machine (e.g., the electronic device **101**). For example, a processor (e.g., the processor **120**) of the machine (e.g., the electronic device **101**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the “non-transitory” storage medium is a tangible device, and may not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer’s server, a server of the application store, or a relay server.

According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities, and some of the multiple entities may be separately disposed in different components. According to various embodiments, one or more of the above-described components or operations may be omitted, or one or more other components or operations may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

While the disclosure has been illustrated and described with reference to various example embodiments, it will be understood that the various example embodiments are intended to be illustrative, not limiting. It will be further understood by those skilled in the art that various changes in form and detail may be made without departing from the true spirit and full scope of the disclosure including the appended claims and their equivalents. It will also be understood that any of the embodiment(s) described herein may be used in conjunction with any other embodiment(s) described herein.

What is claimed is:

1. An electronic device comprising:

a radio frequency processing module comprising radio frequency circuitry;

a first power amplification circuit connected to the radio frequency processing module;

a second power amplification circuit connected to the radio frequency processing module and the first power amplification circuit; and

a front-end module comprising circuitry connected to the second power amplification circuit and an antenna and configured to transmit a signal,

wherein the second power amplification circuit is configured to acquire, from the first power amplification circuit, a first signal obtained by amplifying a signal output from the radio frequency processing module and acquire a second signal by amplifying a signal output from the radio frequency processing module, based on a combination of frequency bands for a first communication scheme and a second communication scheme, and

to switch at least one of the first signal or the second signal to at least one output port connected to the front-end module, based on a first frequency band of the first signal and a second frequency band of the second signal.

2. The electronic device of claim 1, further comprising a processor electrically connected to the radio frequency processing module and configured to control operations of the first power amplification circuit and the second power amplification circuit,

wherein the front-end module is configured to transmit at least one of the first signal or the second signal input through the at least one output port, through the antenna,

wherein the first communication scheme corresponds to a 5G communication scheme, and

wherein the second communication scheme corresponds to a 4G communication scheme.

3. The electronic device of claim 1, wherein the first power amplification circuit comprises at least one power amplifier configured to amplify at least one signal input from the radio frequency processing module, and

is configured to output at least one signal output from the at least one power amplifier, to the second power amplification circuit through at least one output port connected to the second power amplification circuit,

wherein the at least one amplified signal comprises the first signal of the first communication scheme.

4. The electronic device of claim 1, wherein the second power amplification circuit comprises:

at least one power amplifier configured to amplify at least one signal input from the radio frequency processing module; and

a switch module comprising at least one switch configured to switch at least one signal amplified from the at least one power amplifier and at least one signal input from the first power amplification circuit, to the at least one output port connected to the front-end module.

5. The electronic device of claim 4, wherein the switch module comprises at least one switch connected to at least one output port of the first power amplification circuit and at least one switch connected to at least one amplifier of the second power amplification circuit, and

wherein the at least one amplified signal comprises the second signal of the second communication scheme.

6. The electronic device of claim 4, wherein the switch module is configured to switch the first signal to a first output port among the least one output port to transmit the first signal, and

to switch the second signal to a second output port among the at least one output port to transmit the second signal, and

wherein the first frequency band is different from the second frequency band.

7. The electronic device of claim 4, wherein the switch module is configured to switch one of the first signal or the second signal to one of the at least one output port based on the first frequency band being identical to the second frequency band.

8. The electronic device of claim 1, wherein the front-end module comprises a switch module comprising at least one switch configured to switch at least one signal output from at least one of the first power amplification circuit or the second power amplification circuit,

wherein based on the first signal is input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, the switch module is configured to switch the first signal to a first output port among output ports of the front-end module connected to the antenna, and

to switch the second signal to a second output port among the output ports of the front-end module, and

wherein the first frequency band is different from the second frequency band.

9. The electronic device of claim 8, wherein the switch module is configured to switch one of the first signal or the second signal to one of the output ports of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit, and

wherein the first frequency band is identical to the second frequency band.

10. A method for wireless communication in an electronic device comprising a wireless communication module, the method comprising:

amplifying a signal output from a radio frequency processing module of the wireless communication module, by a first power amplification circuit of the wireless communication module, based on a combination of frequency bands for a first communication scheme and a second communication scheme;

acquiring, as a first signal, an amplification signal output from the first power amplification circuit, and acquiring a second signal by amplifying a signal output from the radio frequency processing module, based on the combination of the frequency bands, by a second power amplification circuit of the wireless communication module; and

switching at least one of the first signal or the second signal to at least one output port connected to a front-end module of the wireless communication module, by the second power amplification circuit, based on a first frequency band of the first signal and a second frequency band of the second signal.

11. The method of claim 10, further comprising:

amplifying the first signal to be transmitted in the first frequency band of the first communication scheme, by the first power amplification circuit;

outputting the first signal upon an input of the second power amplification circuit; and

transmitting at least one of the first signal or the second signal input through the at least one output port, through the antenna by the front-end module,

wherein the first communication scheme corresponds to a 5G communication scheme, and

wherein the second communication scheme corresponds to a 4G communication scheme.

12. The method of claim 10, wherein the switching of at least one of the first signal or the second signal to the at least one of the output port connected to the front-end module of the wireless communication module comprises:

switching, by the second power amplification circuit, the first signal to a first output port among the least one output port to transmit the first signal; and

switching the second signal to a second output port among the at least one output port to transmit the second signal, and

wherein the first frequency band is different from the second frequency band.

13. The method of claim **10**, wherein the switching of at least one of the first signal or the second signal to the at least one output port connected to the front-end module of the wireless communication module comprises switching one of the first signal or the second signal to one of the at least one output port based on the first frequency band being identical to the second frequency band.

14. The method of claim **10**, further comprising switching the first signal to a first output port among output ports of the front-end module connected to the antenna, and switching the second signal to a second output port among the output ports of the front-end module, by a switch module of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit,

wherein the first frequency band is different from the second frequency band.

15. The method of claim **10**, further comprising switching one of the first signal or the second signal to one of the output ports of the front-end module, by a switch module of the front-end module based on the first signal being input from at least one of the first power amplification circuit or the second power amplification circuit and the second signal being input from the second power amplification circuit,

wherein the first frequency band is identical to the second frequency band.

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